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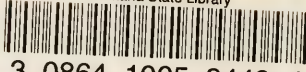
NINTH BIENNIAL
REPORT

1931 - 1932

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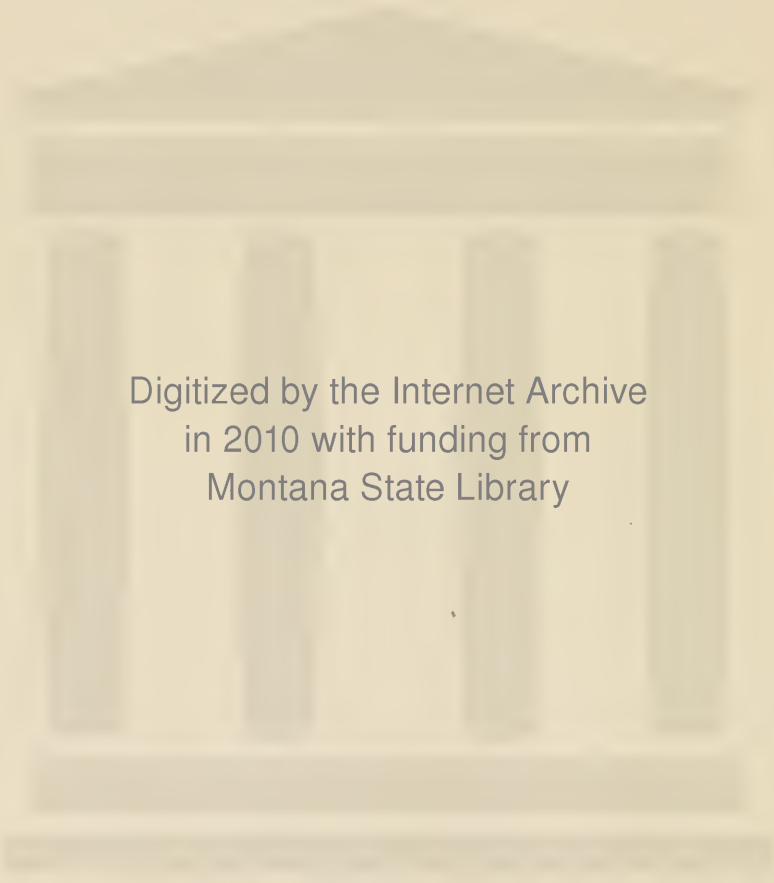
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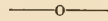
Montana State Board of Entomology

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Member, Helena, Montana.

A. L. STRAND, PH. D., *State Entomologist*,
Secretary, Bozeman, Montana.

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LETTER OF TRANSMITTAL

Bozeman, Montana, April 14, 1933.

To His Excellency, Frank H. Cooney,
Governor of Montana.

My dear Sir:

The Montana State Board of Entomology was created by an act of the legislature in 1913. The primary purpose of this board was to study Rocky Mountain spotted fever and other arachnid- and insect-borne diseases of man and animals within the State of Montana, and to carry out any methods for the suppression of such diseases as might seem advisable.

In eight previous biennial reports the work and accomplishments on spotted fever have been recorded. These reports constitute an important series of scientific documents and have been preserved in the important libraries of the world. This may seem to be an unwarranted use of public money. However, in this regard it should be remembered that no less than seven organizations (The American Medical Association, Harvard University, The Institute of Infectious Diseases, The Rockefeller Foundation, The University of Chicago, The University of Minnesota, and The University of Paris) with no particular interest in Montana have devoted both money and personnel toward the investigation of Rocky Mountain spotted fever. Progress has been attained through the cooperation and research efforts of the above named private institutions and many other public ones. It is, therefore, only fitting and proper that these reports be published. Science has no political boundaries and especially in the matter of public hygiene, the one human endeavor on which all countries of the world can unite with truly mutual benefit, can scientific intercourse be most advantageously promulgated.

From 1913 to 1932 the Board of Entomology supported both control and investigational work in regard to ticks and spotted fever in the Bitter Root Valley. In 1914 the disease spread to some eastern Montana counties and during 1916 and 1917 investigational studies were also carried on by the board in Powder River and Musselshell Counties. By 1920 the situation in regard to the disease became so acute that the board realized that either the state must enter into a more fundamental study of the whole proposition or seek some federal agency which would. Failing in an attempt to obtain greater support from the 1921 legislature, an appeal was made to the U. S. Public Health Service. Accordingly, in 1921 that organization began the most exhaustive study of spotted fever yet undertaken. Its most outstanding accomplishment has been the perfection of a prophylactic vaccine which has done more to allay the fear of ticks and spotted fever than all other accomplishments in the study of the disease combined.

By 1930 it was very apparent that Rocky Mountain spotted fever was a national problem. The state laboratory at Hamilton, space in which had been rented to the U. S. Public Health Service, was taxed to capacity, incident to the production of vaccine for many other states besides Montana. After the necessary preliminary discussions with the federal health authorities, the State Board of Entomology recommended to the state legislature and the State Board of Examiners that the state sell its laboratory to the federal government. This transaction was consummated

and the state fully reimbursed for the physical plant and equipment early in 1932. Not only was the laboratory but also all investigational work formerly carried by the state turned over to the Public Health Service. This left only the control work, stock dipping and rodent destruction, under the jurisdiction of the State Board of Entomology. With the general reduction in its activities, and by further limiting the control work, it was possible for the board to reduce its expenditures of state money during 1932-33 from an original appropriation of about \$26,000 (in the 1931 budget) to \$5,200, or better than 80 per cent.

The 23rd session of the legislature appropriated \$3,000.00 for the continuance of the control work in the Bitter Root Valley. This will be insufficient to maintain the same degree of effectiveness formerly possible. The dipping vats will be kept filled and regulated as to proper strength during the dipping season, but only unoccupied private land within the control areas will be treated for rodents. Likewise some supervision will be given to additional control work made possible by any appropriations from Missoula and Ravalli Counties.

It is recommended that this report be published as the Ninth Biennial Report of the State Board of Entomology.

Respectfully yours,

A. L. STRAND, Secretary.

**CONTROL WORK: ROCKY MOUNTAIN SPOTTED FEVER CONTROL
DISTRICTS, BITTER ROOT VALLEY, FOR THE BIENNIUM
ENDING DECEMBER 31, 1932.**

By F. J. O'DONNELL, *Field Agent*,
Montana State Board of Entomology.

The spotted fever control work in Missoula and Ravalli counties as carried on by the State Board of Entomology during the past two years has been more or less a continuation of the methods applied for the past 8 or 10 years. The work has been financed jointly by the Counties and the State, and the work done under the supervision of the State Board of Entomology. The wood tick parasite work was taken over by the United States Public Health Service on July 1st, 1931. There was, therefore, no money expended for this activity by the State, for the biennium just closing. Rodent control and stock dipping were carried on as in previous years.

The full program was carried out for the fiscal year ending June the 30th, 1932, but due to economic conditions the program was considerably reduced for the fiscal year ending June 30th, 1933. For the fiscal year ending June 30th, 1932, Missoula County appropriated \$2000.00, Ravalli County appropriated \$3,000.00 and there was available from the State about \$13,000.00. For the fiscal year ending June 30th, 1933, Missoula made no appropriation. Ravalli County reduced their appropriation from \$3,000.00 to \$1,000.00 and the Board of Entomology appropriation was reduced to approximately \$5,000.00. With this drastic cut in the appropriations it was necessary to drop a considerable part of the rodent control work. There will be no work done in the control districts in Missoula County, except what rodent control is done by land owners or residents. With the reduced appropriation in Ravalli County it will be possible only to care for unoccupied lands, State and County lands, and a part of the Government land within the districts. Privately owned and occupied land will have to be taken care of by the owner or resident on these lands. Rodent poison will be prepared and available at this Station, free of charge, in reasonable amounts for all lands within the control districts.

It is expected, however, that it will be possible to carry on the dipping program as in the past, with the exception that field men will not always be available to assist the stockmen at the vats. All of the vats will be filled and the dipping solution will be kept up to full strength through the dipping season.

RODENT CONTROL. The accompanying table summarizes the rodent control work in both Missoula and Ravalli Counties. It will be noted that there was a considerably larger acreage (61,280 acres) poisoned in Ravalli County for the years 1931 and 1932, as compared with the previous biennium, while in Missoula County there was a decrease of

38,182 acres. The increase in Ravalli County in both 1931 and 1932 was due to favorable weather conditions, that is, the field crews were able to put in practically full time from the time the rodents first appeared until the close of the season. The decrease in the acreage treated in Missoula County was due to the fact that part of the appropriation made for this work by Missoula County for the 1931 season was not expended. The Commissioners made an appropriation of \$2000.00 but due to the operation of the County Budget Law, no part of this appropriation could be expended after July 1st, 1931, and about \$600.00 reverted leaving only \$1,400.00 from the County Appropriation available for the work.

The average cost per acre in Ravalli County, based on the actual cost of material used and the necessary labor required to do the field work, was slightly less (.0008 cents) for the years 1931-32 than for the preceding two years. The average cost per acre in Missoula County was slightly greater (.0025 cents) for the years 1931-32 than for the period 1929-30. This increase was due to the greater use of calcium cyanide, the cost of which is much higher than that of poisoned grain, and involves an increase of about 100 percent in labor charges for distribution.

For several years rodent baits prepared at this Station have been made with steam crushed oats. During the 1931 season experiments were carried on with a poisoned grain bait made with whole oats from a formula recommended by the United States Biological Survey. A number of experiments carried on in several of the districts indicated that there would probably be some advantage in using the whole oat bait in preference to the steam crushed oat. Accordingly during the 1932 season there was about 60 percent of the whole oat bait and about 40 percent of the crushed oat formula used. The advantage of the whole oat bait seemed to be in the fact that there was less dusting or loss of the active ingredient, strychnine, while the grain was being handled and distributed in the field. In our field tests when equal amounts of the whole oat and crushed oat baits were consumed, the kill was apparently about the same. However, the whole oat bait seemed to be more attractive to the rodents and when baits of the whole and of the crushed oats were placed in the same burrow the rodents almost invariably ate the whole oat in preference to the crushed oat bait. Also the whole oat bait formula contains a percentage of heavy petrolatum oil which protects the bait, for a short time at least, during wet weather. For the 1933 season the new formula will be used exclusively.

The control work for the past two years in both Counties has been very satisfactory. There has been a marked decrease in the rodents in the districts in both Counties, and we have had splendid cooperation from the residents and land owners in all of the districts. We have continued our intensive rodent work over the areas at the eastern end of Lake Como. Reference to this work was made in the last biennial report. This area continues to be increasingly popular with campers, picnickers and boating parties on Lake Como. Rodent destruction by poisoned baits, trapping and shooting was supplemented by tick dragging. About 4000

acres were subjected to this intensive control work. As a result there is a very noticeable decrease in the number of rodents and also in the number of ticks as was proved by a check made on the number of ticks collected by dragging.

DIPPING. There has been an increasing interest among the stockmen in stock dipping as is indicated by the following figures. For the years 1927-28 there were 2073 animals dipped; in 1929-30 there were 2588, for the seasons 1931-32 there were 11,399. These figures include all animals—cattle, horses, sheep, etc., and show an increase of 340.0 per cent for the past four years. This increase indicates the attitude of the stockmen in regard to dipping and it is believed that with double the number of vats now available, there would be very close to 100 per cent of the stock within the districts dipped each year. The increased interest in stock dipping has been brought about, not by any threat of enforcing the law concerning the dipping of stock within the control areas, but through circular letters prepared at this office emphasizing the importance of dipping and through the voluntary efforts and co-operation of the stockmen. The stockmen as a whole have begun to realize that the dipping of their stock not only destroys the wood tick but also lice and other vermin, and causes a more rapid and earlier shedding of the winter coat. In general it is safe to say that animals dipped in the early spring are at least two weeks ahead of undipped animals. This statement, of course, does not apply to sheep as these animals should not be dipped before shearing.

The vats at Florence, Stevensville, Victor and Hamilton are all in good condition and with only minor repairs can be put into service within a short time. The Gold Creek vat which is of concrete construction, has been used only a few times during the past 8 years, for the reason that the side walls and bottom have developed slight cracks which permit seepage of ground water in sufficient quantities to dilute and render valueless the dip solution, unless the vat is used within 48 hours after filling. No effort has been made to install a galvanized metal lining in the Gold Creek vat or make other necessary major repairs, for the reason that the State does not have the title to the vat site. Also, it was felt inadvisable to expend any great amount of money on this vat as the site is not in a desirable location.

STOCK POISONING. Thirteen cases of alleged stock and poultry poisoning were investigated during the past two years. In all cases, when at all possible to do so, a postmortem examination was made by a veterinarian and a specimen of stomach contents was submitted to the chemist of the Livestock Sanitary Board at Helena for examination. It was definitely determined that three turkeys had died as a result of eating poisoned grain distributed by our field men. One steer was poisoned by licking the residue from a calcium cyanide can which had not been thoroughly cleaned before it was discarded by the field men, and 10 sheep had apparently been killed by calcium cyanide gas. The sheep were turned into a pasture which had just been "gassed" and had evidently inhaled the cyanide gas by placing their noses down into the ro-

dent burrows to avoid the nose flies which were numerous at that time. The total cost of settlement for the turkeys, steer and sheep was \$50.94. Considering the vast acreage poisoned by our field crews each year, the loss from poisoned stock for the past four years has been negligible.

The drastic cut in the appropriations made by both the State and the Counties will necessitate radical changes in the control program. As stated before it will not be possible to employ field crews to cover the entire area of the control districts as has been done in the past. Only the unoccupied private land and State and County land within the control areas will be treated by field crews during the 1933 season and it is quite probable that only one poisoning will be made on most of these lands. Whether or not it will be possible to poison any of the National Forest land in the foothills west of the cultivated areas, will depend upon the funds available after the other lands in the districts have been treated. If the owners and occupants of the cultivated areas will make a concerted effort to poison the rodents on their lands, it may be possible to hold the rodent population at its present status, however, past experience has shown that the average farm owner or renter will not do a thorough job of rodent poisoning and many of them will do little if any poisoning. If this latter condition prevails it will be only a short time until, by migration and natural increase, the rodents will be as numerous as they were before rodent control work was initiated, and all of the work done up to the present time, will be of little value. That the control work has justified itself is evidenced by the remarkably few cases of spotted fever which have occurred during the past few years within the control districts proper, and it is to be hoped that economic conditions will improve so that it may be possible within a short time to again carry on the control work as has been done in the past.

We wish to acknowledge our appreciation for the splendid cooperation we have received from the Montana Livestock Sanitary Board in making laboratory examination of animal specimens, stomach contents, etc., submitted to them during the past two years. Also we wish to acknowledge the assistance given us by Mr. Glen M. Kohls and Mr. W. L. Jellison of the U. S. Public Health Service at this Station, in making tests of dip solutions for the past biennium; and the Division of Food & Drugs of the State Board of Health for making tests of the arsenic used in our dip solutions.

State Board of Entomology
SUMMARY COLUMBIAN GROUND SQUIRREL CONTROL,
RAVALLI AND MISSOULA COUNTIES

RAVALLI COUNTY CONTROL DISTRICTS

Year	Poisoned Once Acres	Poisoned Twice Acres	Grain Poison Quarts	Calcium Cyanide Pounds	Labor Hours	Average Cost per Acre for Treatment
*1927	86,093.40	48,131.12	5,910.75	2,155.00	6,968.83	.0340
*1928	91,851.50	21,514.00	5,700.00	2,137.50	7,421.92	.0417
*1929	99,161.26	54,536.39	5,569.00	2,411.00	7,433.42	.0309
*1930	91,440.90	45,382.50	4,850.75	4,575.00	7,561.50	.0366
*1931	107,660.00	51,785.00	6,787.90	4,151.00	6,970.33	.0326
*1932	107,891.33	84,465.00	7,869.00	5,800.00	9,784.17	.0332

MISSOULA COUNTY CONTROL DISTRICTS

1927	55,650.00	56,823.00	1,874.50	575.00	4,154.50	.0203
1928	72,310.00	51,580.00	1,898.00	309.00	4,058.50	.0177
1929	82,040.00	53,250.00	1,992.50	563.00	3,995.50	.0165
1930	85,220.00	49,490.00	1,835.00	686.00	4,085.50	.0168
1931	78,329.00	42,960.00	1,210.00	586.00	3,301.00	.0146
1932	69,186.00	41,397.00	1,375.00	1,920.00	4,194.00	.0212

U. S. Lands and National Forest

1927	4,200.00	80.00	182.50		220.66	.03108
1928	8,160.00	400.00	620.00		657.83	.0481
1929	7,680.00	1,400.00	415.25		214.33	.0194
1930	10,225.00	1,580.00	520.00	100.00	623.00	.0332
1931	7,760.00	1,280.00	241.00	100.00	275.00	.0204
1932	7,460.00	2,800.00	489.00		557.50	.0309

*U. S. Lands and National Forest Included.

TABLE 1.
ROCKY MOUNTAIN SPOTTED FEVER IN MONTANA
Cases and Deaths, 1914-1932, by County of Infection

COUNTY	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	Total	Deaths	Fatality Rate %
Beaverhead							1					1					1		4	9	2	22.2
Big Horn		2				1	1		1	1	1	2	3	2	1				3	18	3	16.7
Blaine									1										2	3	0	
Broadwater				1			1			2	1		1					1	1	8	3	37.5
Carbon	3	3	1	4	2	1	1		3	3	4	3			3	2	2	2	4	41	6	14.6
Carter		4								2	3	1	1			1			4	16	4	25.0
Cascade																						
Chouteau																	1			1	0	
Custer	6								1		1	2	3	1				2	16	1	6.3	
Daniels																						
Dawson									1										2	3	1	33.3
Dear Lodge																						
Fallon									2	1	3	1	1	3					2	13	3	23.1
Fergus			1	2		2	2	1	4	3	3				1	1		2	3	25	5	25.0
Flathead																						
Gallatin		2							1									1	1	6	2	33.3
Garfield		6	3	1		1	1		5	14	4	1	3	5	1			2	5	52	9	17.3
Glacier																						
Golden Valley								1	1	1	1		1	1					2	8	0	
Granite			1							1	1								2	5	1	20.0
Hill																	1			1	0	
Jefferson																						
Judith Basin									1	1		1	1	1					1	6	0	
Lake																		1	1	4	3	75.0
Lewis & Clark						1	3	1	1	2	1	1		1	1	1		1	14	1	7.1	
Liberty																						
Lincoln																			3	5	1	20.0
McCone								2											2	5	1	20.0
Madison																						
Meagher				2	1					1									1	2	1	50.0

STATE BOARD OF ENTOMOLOGY

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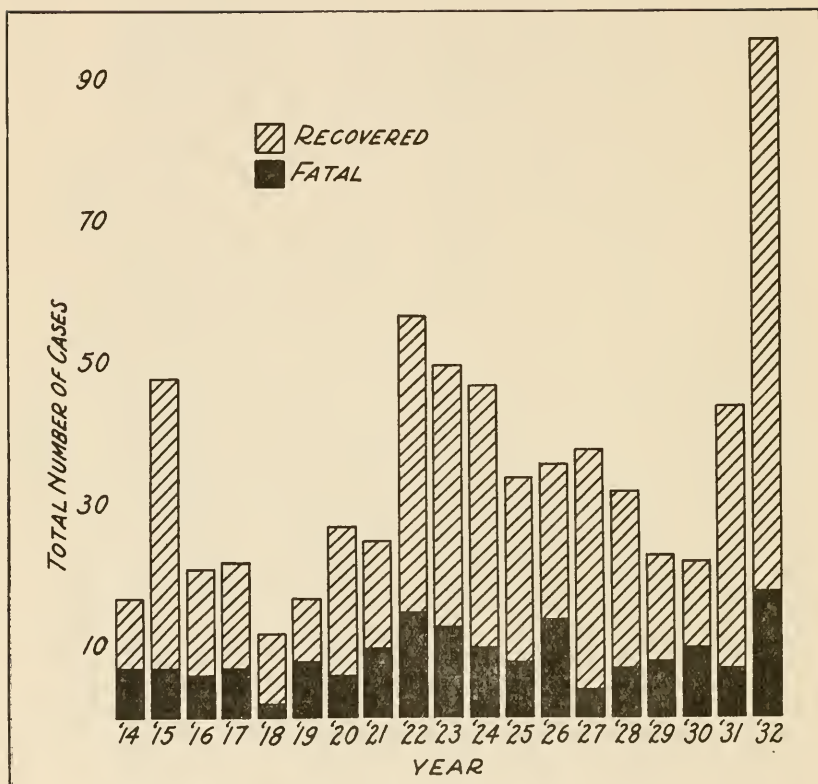


FIGURE 1

Figure 1. Graphic representation of the incidence of Rocky Mountain spotted fever in Montana from 1914 to 1932.

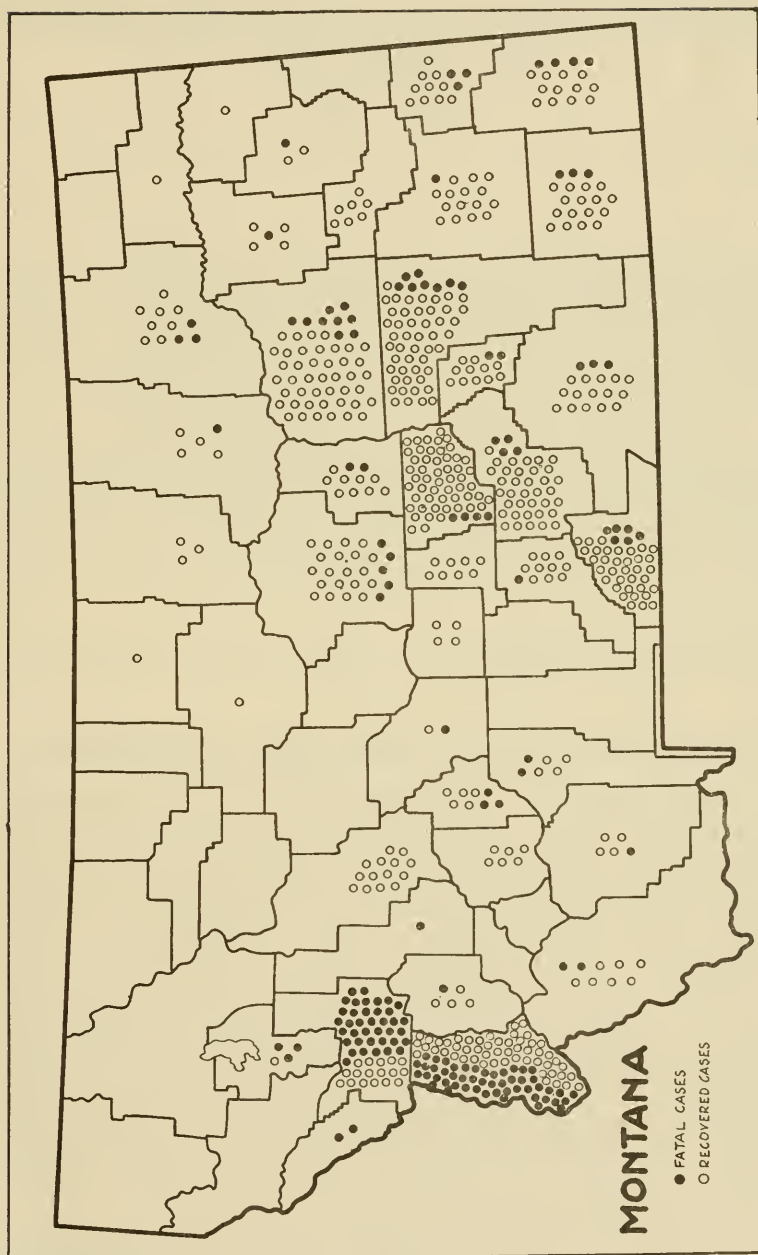


Figure 2. Distribution of Rocky Mountain spotted fever in Montana including the entire period of 1914 to 1932.

ROCKY MOUNTAIN SPOTTED FEVER IN MONTANA 1914 - 1932

Table I was prepared by Dr. J. H. Crouch, Epidemiologist for the Montana State Board of Health. Records of the Board of Health, Helena, were checked against records of the U. S. Public Health Service, Hamilton, Montana. Care was taken to record each case according to the county in which infection took place, and not according to the county in which death occurred or where hospitalization was obtained.

Figure 1 shows in graphic form the information contained in Table I. The increase in the number of cases of spotted fever in 1932 was phenomenal. There is little doubt that the wood tick (*Dermacentor andersoni* Stiles) was far more abundant over the state as a whole than in any other year during which observations have been made. Although the number of cases was high the percentage of fatal cases was relatively low.

Figure 2 shows the distribution of Rocky Mountain spotted fever in Montana from 1914 to 1932.

FUTURE WORK OF THE STATE BOARD OF ENTOMOLOGY

The organization of the Montana State Board of Entomology has been well suited to the function which it was created to fulfill. The Montana State Board of Health, concerned with the promotion of the health of man, and the Montana Livestock Sanitary Board, concerned with the promotion of the health of domestic animals, are brought into contact with the chief entomological agency in the state. As a result the treatment of all problems having to do with aracid- or insect-borne diseases, or of insect pests which are important in any way to the health of man and livestock, is thereby placed in the hands of an organization which can consider them from all possible viewpoints. This arrangement has certainly been beneficial to the state in the work accomplished on spotted fever. Now that the Board of Entomology has only the control work relative to the suppression of the Rocky Mountain spotted fever tick, it can very well consider other problems of the state in which insects are concerned with the health of man and animals. Some of these have received attention in the past.

At the 94th meeting of the board, October 13, 1932, the following general outline of the problems which should receive attention was presented by the secretary:

- A. The control of insects and allied species which disseminate disease
 - 1. Control of ticks as carriers of Rocky Mountain spotted fever, tularaemia, tick paralysis.
 - 2. Control of house flies and similar household insects.
- B. The control of insects which even though they carry no known specific diseases are detrimental to the welfare of man and animals.
 - 1. Mosquitos in irrigated regions, in the drainage areas of the Missouri and Yellowstone rivers, the Flathead region. The mosquito problem at "Dude" ranches at times is a serious and limiting factor in the development of this important "industry" in Montana.
- C. The control and investigation of insects in relation to livestock.
 - 1. Ticks, bot flies, horse flies, warble flies, mites.
- D. The control of insects in relation to general agricultural crops in so far as the health of man and animals may be concerned.

A CHRONOLOGICAL SUMMARY OF THE INVESTIGATIONS ON ROCKY MOUNTAIN SPOTTED FEVER WITH ESPECIAL REFERENCE TO THE WORK IN MONTANA

By A. L. STRAND

The withdrawal of the Montana State Board of Entomology from active investigations dealing with Rocky Mountain spotted fever and the assumption by the U. S. Public Health Service of the entire research program in 1931, makes this a logical time to review briefly the history of the work which has been done on this important disease in Montana. It is not the purpose of this article to dwell on the information which has been accumulated, for it is published in detail elsewhere, but rather to record chronologically the progress of these investigations with especial reference to the many workers who have contributed to our knowledge of the disease, some of whom also contributed their lives.

Support for the thirty years' work done on the disease in Montana has come, directly or indirectly, from some twenty-three sources. State and federal governmental agencies, universities, private individuals and private companies, various foundations and associations, have contributed money and the services of highly trained workers to these investigations. The occasion is taken in this report for the people of Montana, through their State Board of Entomology, to voice their thanks and appreciation to those organizations outside of the state of Montana who, through purely altruistic or scientific interest, have made possible many of the most significant discoveries relative to Rocky Mountain spotted fever.

Rocky Mountain spotted fever has been recognized as a distinct clinical entity by western physicians since about 1890. The first account of the disease, however, is to be found in the Report of the Surgeon General of the Army for 1896, written by W. W. Wood. This had to do with the disease as it occurred in Idaho. It was followed shortly (1899) by an article published in the (Portland) Medical Sentinel by Dr. E. E. Maxey, in which a very excellent clinical description of the disease was given. Dr. Maxey's observations also were based upon the disease in Idaho.

The first accounts of the disease so far as its occurrence in Montana is concerned are those of McCullough, and Wilson and Chowning. (Gwinn and McCullough had read a paper on spotted fever before the Montana State Medical Association in 1899 but it was not printed.) Prior to these records, the early history of the disease here is vague and unreliable. It is known that two cases occurred in the Bitter Root Valley in 1873 and that the Indians were not immune to the disease. Probably many died of it during the early spring months when evil spirits seemed to inhabit certain canyons contiguous to the Bitter Root Valley.

It is interesting to note that the Lewis and Clark Expedition traversed the old Indian trail that follows Lo Lo Creek on both their west-

ward and eastward journeys. Going west it passed through the Bitter Root Valley and up the Lo Lo in September, 1805, so it is not surprising that they escaped the disease at that time; but on the eastward trip the expedition passed down Lo Lo Creek in June and camped at "Travelers' Rest" (near the mouth of Lo Lo Creek) on June 30, 1806. No mention of tick bites or any subsequent sickness that can be interpreted as spotted fever is made in any of the journals of the expedition.

The Period of Wilson and Chowning

The first actual investigation of Rocky Mountain spotted fever began in 1902. Dr. A. F. Longeway, then secretary of the Montana State Board of Health, by correspondence and finally by a personal visit, directed the interest of the Minnesota State Board of Health and the University of Minnesota to the disease. As a result of this mission on the part of Longeway, Drs. L. B. Wilson and W. M. Chowning, of the University of Minnesota, took up the study of this mysterious sickness of the Rocky Mountain region. They were engaged "to investigate the nature, causation, and means of prevention of the disease", the expense connected with the work to be paid by the Montana State Board of Health.

Wilson arrived in Missoula, Montana, on May 16, 1902, and Chowning on May 26, 1902. They both stayed until July 14, 1902. During this time they studied seven cases clinically and performed six autopsies. In June of this same year, Dr. F. F. Westbrook, Professor of Pathology and Bacteriology, University of Minnesota, and director of the Minnesota State Board of Health, and Dr. J. O. Cobb, Surgeon of the U. S. Public Health and Marine Hospital Service, visited Missoula and in company with Wilson and Chowning examined clinically case No. 96. They studied fresh blood preparations and microscopic specimens from previous autopsies and also from "spermophiles". Dr. Westbrook assisted by making sketches, observations on prepared tissues, etc. During 1902 Wilson and Chowning obtained records on the incidence and mortality of the disease. They returned to Montana in 1903 and studied 10 cases clinically and performed two autopsies, besides collecting much other data. It is important to record here that they performed inoculation experiments. Spleen pulp and heart's blood removed at autopsy No. 6, were inoculated four hours after the death of the patient into the breast muscle of two pigeons and subcutaneously into the right groin of two rabbits. The blood of the pigeons was examined several days later but no organisms found. The rabbits on the day following inoculation showed a rise in temperature. Intracellular organisms were found in the blood of both rabbits and continued present in blood collected on successive days for two weeks. One animal was then killed. The spleen was enlarged and darker than normal. No microscopic lesions in any other organs were noted. Examinations of prepared tissues showed many organisms indistinguishable morphologically from those found in tissues from human cases.

Wilson and Chowning deserve everlasting credit and praise from the people of Montana for initiating the investigation of Rocky Mountain

spotted fever. By coming here they attracted almost immediately the attention of other scientists. As a result, from the time they arrived at Missoula in May, 1902 up to the present time the scientific investigation of the disease has been continued without interruption. They established several important points in regard to the disease and furnished evidence which contributed to the establishment of many others. Since this was the first organized research directed toward the solution of the problem the general conclusions of Wilson and Chowning deserve more than passing attention.

One should first consider the fact that the amount of sound knowledge about the disease until 1902 was practically negligible. Ticks¹ had been suspected but few people believed in such a theory. Many water analyses had been performed without any results, lending support to that mode of infection. Mr. Emil Starz as a member of a committee appointed by the State Board of Health, reported that all evidence showed that the disease was not water-borne. Yet infection in early spring through the water supply seemed to be the most generally accepted idea. Wilson and Chowning were able to draw the following conclusions which are expressed largely in their own language:

- a. That the disease was not contagious. No evidence could be obtained that the disease found entrance by way of the digestive, respiratory, or genito-urinary systems.
- b. That the disease and tick activity occurred at the same time of year.
- d. That the occurrence of the disease in isolated cases in a region sharply limited on one side by a river indicated the conveyance of the germs to man (if by any animal) by a temporary parasitic animal which traveled slowly and not widely and which was not carried by the wind, etc. The tick answered the description.

In spite of the fact that the piroplasma described by Wilson and Chowning as the probable casual organism of the disease was not valid, their sound general analysis of the problem places their work on a very high plane of accomplishment.

One further point in regard to their work is worthy of some cogitation. The life history of *Dermacentor andersoni* Stiles was not known. No one had shown that the adult tick, accredited by Wilson and Chowning as being the probable transmitter of spotted fever, was the same species as the immature form on ground squirrels. Yet Wilson and Chowning emphasized the probability that the Columbian ground squirrel (*Citellus columbianus*) was the carrier of the disease in nature. Their conclusion was not correct but their premise, to one familiar with this problem, was an astonishingly accurate assumption.

In 1903 the Montana State Board of Health saw that it would not be able to lend any further financial support toward continuing the work

1—In this account the word tick, when not otherwise indicated, refers to *Dermacentor andersoni* Stiles

begun by Wilson and Chowning. It appealed to the U. S. Public Health and Marine Hospital Service for aid. In response to that request, Dr. John F. Anderson, past assistant surgeon and assistant director of that organization, spent the month of May, 1903, in the Bitter Root Valley. He worked over some of the same material as Wilson and Chowning, studying five cases and performing one autopsy. In his report he agreed that the tick was the probable carrier of the disease but he added nothing toward further confirmation.

Dr. C. W. Stiles, of the U. S. Public Health and Marine Hospital Service, spent two months in the Bitter Root Valley, with headquarters at Missoula, in the summer of 1904. The conclusions based upon his observations were mostly negative. The work of Wilson and Chowning was given no support by him. He could not find their piroplasma in new blood preparations nor in preparations furnished him by Wilson and Chowning. Stiles showed that there was no tick common to the infected district that was not common to other parts of the state. He flatly contradicted the tick theory. These findings retarded the study of the disease for the ideas which had stimulated the investigation were apparently exploded. Stiles carried out inoculation experiments in which blood from three fatal cases was injected into rabbits. The blood of these rabbits was repeatedly examined but with negative results.

In 1905 Dr. E. Francis of the U. S. Public Health and Marine Hospital Service spent a short time on spotted fever investigation in the Bitter Root Valley. Like Stiles, he did not lend any support to the tick theory of transmission. It is evident that the practice of the federal health authorities in sending a new man each year to work on spotted fever did not give any of them a fair chance to arrive at conclusions based on much experimental data. This constant change in personnel was later criticized by Ricketts. It had also been protested by Dr. Tuttle, of the Board of Health.

The Period of Ricketts

It is true that Drs. McCalla and Brereton of Boise, Idaho, in 1905, infected a man and a woman with the mild form of the disease by allowing a tick, which had been removed from a fever patient, to bite one and then the other. It was not known at this time, however, that the Idaho and Montana forms of spotted fever were strains of the same disease. Furthermore, the experiment above was given very little publicity and was unknown to the scientists working on the disease in Montana.

In this state, up to 1905, the tick theory of transmission had been supported by some workers and vigorously denied by others. The time was just right for some one to settle the matter. Progress in controlling the disease could not go forward until this controversy was settled. None of the workers who had come to Montana performed any experiments to show definitely that the tick could or could not transmit the casual organism from man to test animal or from animal to animal.

On April 21, 1906, Dr. H. T. Ricketts of the University of Chicago, arrived at Missoula. He took up residence at the Northern Pacific Hos-

pital where he was also furnished laboratory facilities by the physician in charge, Dr. E. W. Spottswood. Ricketts came entirely of his own volition. In his own words, he came because the piroplasma of Wilson and Chowning had been disputed by Dr. Stiles, a high authority. There was a difference of opinion and it seemed an opportune time for a third person to take up the work. One day during the summer while at lunch with the nurses and Prof. R. A. Cooley, he expressed the idea that he found himself in Montana due to his sympathy "for the underdog".

Not long after Dr. Ricketts had established himself in the Northern Pacific Hospital, Dr. W. W. King, of the U. S. Public Health and Marine Hospital Service, arrived in Missoula. He also made the hospital his headquarters and for several weeks during the early summer of 1906, Ricketts and King worked side by side. An important consideration to be noted here, however, is that Ricketts came prepared for inoculation experiments. Consequently he devoted himself to this angle of the problem from the start, whereas Dr. King at first pursued some microscopical studies.

Ricketts tried to inoculate rabbits with blood from a spotted fever case. There was no reaction with the first two rabbits although one showed a slight rise in temperature. Turning then to guinea pigs, the results of inoculations were much more encouraging. The blood of a patient (Cortsen, Dr. Merrick) was injected into guinea pigs. Following an inoculation period of from two to four days the animals developed temperatures ranging from 104° to 106° F., became emaciated and died, one on the 7th and one on the 11th day. From 36-48 hours before death the temperatures were subnormal. Ricketts noted especially a scrotal swelling in the male guinea pig, the skin of which was infiltrated with blood. This frequently recurring reaction has since been found of considerable diagnostic value. From guinea pigs which died, a second lot was inoculated. One of these latter animals died; two others recovered after a course of high fever and emaciation. From the animal which died, a third generation was inoculated but none of these showed the disease.

Following the successful carrying of the disease from one animal to another by blood inoculations, experiments were performed with ticks as a means of transmission. To quote Ricketts: "a female tick (*Dermacentor andersoni* Stiles) which had fed for about two days on a sick guinea pig transmitted spotted fever to a healthy guinea pig when allowed to bite the latter. Dr. W. W. King obtained a similar result for about the same time. A little later the same year I obtained successful transmission with a male tick in the same manner; and repeated the transmission with a female a number of times".

Until June 11, Dr. King confined himself to his microscopic work but then turned to inoculation experiments with material furnished him by Ricketts. Upon returning to Washington, King took with him one male and three female ticks which had fed on diseased animals. The male tick died but the females gave the disease to healthy guinea pigs

in experiments which were carried out at the Hygienic Laboratory in Washington, D. C.

Dr. King published his report of the successful transmission of Rocky Mountain spotted fever by means of ticks as a very brief note in the Public Health Report for July 27 1906. Dr. Rickett's report appeared seven days later on August 4, 1906, in the Journal of the American Medical Association.

Both Ricketts and King were in the field continuing their studies in 1907. More tick-transmission work was done. It was during this season that Ricketts supplied another link to the chain of evidence against the tick. He obtained the disease from ticks collected in "infected districts". One of the strains so obtained was carried from guinea pig to guinea pig through many passages. Thus it was shown that, in addition to being able to transmit the disease from one affected laboratory animal to another, the tick harbored the disease in nature. The following year he devoted himself to determining the source of infection of the tick. This was not completed, nor is the question yet settled whether the virus of spotted fever is perpetuated by the tick alone or if a combination of ticks and susceptible mammals is necessary. In this connection, Dr. R. R. Parker has shown the likelihood of a complex of a large number of factors resident in nature as concerned in the perpetuation of the virus and that the intensity of the action of the individual factors varies greatly in different areas of infection and even within the different portions of the same area. He has found much evidence that points to rabbits and the rabbit tick as a very significant combination of factors in many sections of the West, and in one part of western Montana has shown that the Rocky Mountain goat is an extremely important local factor. Transmission of spotted fever in nature by the above mentioned rabbit tick was demonstrated by him in 1921. Ricketts discovered the casual organism of the disease and demonstrated it in the tick and especially in the ovaries of the female. In addition he showed that it was carried over from one generation of ticks to the next.

This positive evidence against the wood tick made it highly desirable and indeed imperative to know more about this carrier of the disease. In August, 1907, Dr. T. D. Tuttle, Secretary of the Montana State Board of Health, conferred with the officials of Montana State College, and requested that the Entomologist make a thorough study of the ticks of the State. The request coincided with plans already made by Entomologist R. A. Cooley. Accordingly during the spring and summer of 1908, he conducted studies of the tick as found in the Gallatin Canyon, south of Bozeman, Montana. With the assistance of Mr. W. V. King, much new information on the habits of the tick, its host animals, and the methods of handling was developed. Mr. King was appointed as "agent and expert" of the U. S. Bureau of Entomology, on June 29, 1909, and was designated to make a "tick survey" over the northwestern states, under the supervision of Prof. Cooley. He traveled through parts of Montana, Wyoming, Utah, Oregon and Washington. Much new data on the life history and distribution of *Dermacentor andersoni* as well as other species of ticks was collected.

The 1909 session of the Montana State Legislature appropriated \$6,000 for the Montana State Board of Health, with the specific designation that the money was to be spent by Dr. Ricketts in further studies of the disease and for following up the discoveries already made. In the spring of that year Ricketts was prepared to proceed with the work but as it turned out the money was not actually available. As an alternative, certain citizens of Missoula showed their interest in the work by advancing \$1,000 which allowed Dr. Ricketts to have some tick collecting done for him in the Bitter Root Valley, and to carry on some laboratory work at the University of Chicago.

Dr. W. D. Hunter, of the Bureau of Entomology, U. S. D. A., and Dr. A. K. Fisher, of the Bureau of Biological Survey, together with Prof. R. A. Cooley of the Montana Agricultural Experiment Station, carried on some observational and experimental work with ticks in the Bitter Root Valley during the summer of 1909. It was probably at this time that preliminary arrangements were made for some cooperative research on the disease. Having in mind the many complications involved in the proposition, the study of the wood tick itself, its relation to its host animals as well as the relation of both of these factors to the disease, Prof. Cooley, as did no doubt the other men familiar with the problem, saw that the investigations would be most fruitful if several agencies, each well equipped in its own branch of science, would cooperate in an organized basic study of the whole question. As a consequence, for the continuation of the work in 1910, Dr. Ricketts and his assistants were to handle all phases of the pathological work, the Bureau of Biological Survey was to study the animals which served as hosts for ticks, and the Bureau of Entomology was to work on its life history and development. This plan suited Dr. Ricketts for he no longer desired human material in his studies but intended to confine his work to small wild animals. By such an arrangement it was believed that the most significant progress could be made. Mr. Willard V. King was to be employed by the Bureau of Entomology, under the direction of Dr. Hunter, but under the immediate supervision of R. A. Cooley.

After much consideration and looking about, a camp was established on Sweeney Creek about two and one-half miles southwest of Florence, Montana. This laboratory known unofficially as "Camp Venustus", consisted of a log cabin of three rooms, stables, etc., together with tents which were to serve as sleeping quarters. On March 15, 1910, as shown by correspondence covering the period, W. V. King was already at the camp and A. H. Howell and Clarence Birdseye, of the Biological Survey, were working on the east side of the Bitter Root River but intended to be at the camp within a very few days.

All previous investigators had made their headquarters at Missoula or other fair sized towns, from which trips of short duration were made into the infected districts. This was a comparatively safe procedure for by careful and frequent examinations of the body and clothing ticks could be removed before they had fed long enough to produce the disease. But living in the open through the height of the tick season in one of

the most heavily infested districts was a far different matter. King, Birdseye, Howell, and Paul Stanton, the latter serving as cook and general utility man for the party, as well as R. A. Cooley who visited the camp frequently, deserve credit for this undoubted temerity. By taking such chances the work could be greatly facilitated. No time need be spent in slow travel to and from the real tick locations and as a result, the time for observations and experimental work in all its phases was greatly increased.

In January, 1910, Prof. Cooley wrote to Dr. Ricketts about the possibility of an immunizing serum for the workers who were to be at the Florence laboratory. A horse serum more or less effective on laboratory animals had been prepared at Ricketts' laboratory at Chicago but no trials on human prophylaxis had been made. Granting that point, however, it seemed that fresh administration would have been necessary every two weeks and as there was strong danger of anaphylactic shock with the serum given repeatedly, the matter was dropped.

Early in the fall of the previous year, 1909, the money appropriated by the Montana legislature still not being available, Dr. Ricketts took up the study of a disease closely related to spotted fever, namely, the typhus fever of Mexico. Then in December, 1909, the Montana State Board of Health informed Ricketts that the money was finally ready to be used. In accordance with this new development, and in spite of already being somewhat involved in the typhus problem, Ricketts made arrangements to carry on laboratory work at the University of Chicago through assistants and to send one assistant to Montana as soon as the field work could start in the spring of 1910. He himself left Chicago in December, 1910, and proceeded to Mexico on the typhus fever project. The agreement was that he was to come to Montana the first day of May, 1910. During the last week in April, however, he was stricken with typhus fever and died in Mexico City on May 3, 1910.

To Dr. Ricketts belongs the credit for making by far the greatest contributions to the early study of Rocky Mountain spotted fever. Besides those points already noted, he obtained transmission of the disease with several species of ticks other than the Rocky Mountain wood tick, *Dermacentor andersoni* Stiles. He predicted the spread of the disease to other parts of Montana. Altogether he showed that he had a remarkable insight into the problem. His ideas were very clear in regard to the direction his investigations should take for he started many lines of work and suggested others which are important phases of the research program which is in progress today.

Dr. Ricketts' work was supported by grants from the American Medical Association, the Montana State Board of Health, the University of Chicago, the Memorial Institute of Infectious Diseases, Missoula and Ravalli counties, and by specific appropriations made by the Legislature of the State of Montana.

Josiah J. Moore, now a prominent physician in Chicago, was a student at the State University at Missoula in 1907 when Dr. Ricketts came

to Montana for his second season's work. Moore was employed by Ricketts and helped to carry out many of the tick experiments from 1907 to 1910, both in the Bitter Root Valley and in the pathological laboratories at the University of Chicago. He came back to Montana, at Ricketts' direction, April 23, 1910, to work at the Florence "camp", but upon receiving the news of Ricketts' death, he returned to Chicago.

Howell did not remain at the "camp" for the entire season but Birdseye stayed until July 15 and King until November. Some very fundamental information was collected relative to the tick and its host animals. Previously it had been supposed that the wood tick had a one-year life cycle but observations by King from March to November, 1910, and substantiated by the 1911 work, showed that at least a two-year period was required.

The work was not confined to the Florence district. Various trips were made to other parts of the valley. Birdseye killed and examined (May, 1910) three mountain goats, five black-tail deer, and one elk. The goats were killed above Lake Como and had a great abundance of adult ticks on them. The elk, killed at the north end of Lake Como, had no ticks, nor did any of the deer save one on which a single specimen of *Dermacentor albipictus* was found. These details are mentioned for this was the first indication that the mountain goats support a large tick population.

Dr. W. D. Hunter, of the Bureau of Entomology, Dr. H. K. Fisher, of the Bureau of Biological Survey, and Dr. H. A. Morgan, of the University of Tennessee, visited the Bitter Root Valley in September, 1910, to look over the progress of the work and to receive first hand information on the tick situation. Dr. Morgan had had much experience with Texas fever, a tick-borne disease of cattle, and his advice and consultation proved very valuable to the work in Montana. It should likewise be mentioned that, whereas it may appear that the men at the Florence camp were working independent of outside aid, such was not the case. Doctors Hunter and F. C. Bishopp, of the Bureau of Entomology, with headquarters at Dallas, Texas, gave a great deal of time to the determination of almost every lot of ticks collected and thereby not only facilitated the work but gave it an accuracy which it could not otherwise have enjoyed.

Although the work was very successful in many ways, had Dr. Ricketts been present it would have been greatly unified. Much material of pathological interest had to be discarded because there was no one to study it. However, by 1911, the information needed for the control of ticks and Rocky Mountain spotted fever seemed to be at hand. At least among the scientific workers the mode of transmission had been settled already, the life history, of the principal vector was now fairly well established, and its most important host animals known. The next logical development was to put this information to practical test. If the number of nymphal ticks could be reduced by destroying their rodent hosts, and the adult ticks on domestic animals could be eliminated by

dipping, then the incidence of the disease should be greatly decreased. In fact, Ricketts himself had suggested these two possibilities but not on as sound evidence as was now available.

The Period of Field Experiments on the Control of Ticks

The Bureau of Entomology, the Bureau of Biological Survey, and the Montana Agricultural Experiment Station, cooperated again during 1911. Clarence Birdseye, A. H. Howell, of the Biological Survey, and M. H. Spaulding of the Experiment Station, did further work on the small mammals which serve as tick hosts. W. V. King, of the Bureau of Entomology, while also making further life history studies especially in regard to tick longevity, concentrated on the initiation of a tick control campaign. Under the advice and supervision of R. A. Cooley, King stimulated such an interest in the dipping of livestock that a dipping vat was constructed near Florence, being paid for partly by public subscription. The vat was completed by June 3 and the first stock put through about the middle of the same month.

Dr. H. W. Henshaw, Chief of the Bureau of Biological Survey, and Dr. L. O. Howard, of the Bureau of Entomology, tried early in 1911 to arrange with the Public Health and Marine Hospital Service for some cooperative work on spotted fever in the Bitter Root Valley. Such an arrangement was not favored by the Federal Health authorities as it was believed unnecessary. However, the Public Health and Marine Hospital Service joined with the Montana State Board of Health in an enterprise to exterminate ticks.

Dr. Thomas B. McClintic was sent out by the Public Health and Marine Hospital Service and evidently intended to make his headquarters at Florence, Montana. But after meeting with Dr. Tuttle in Helena, McClintic changed his plans and set up his laboratory at Victor.

Dr. Tuttle was very active during 1911 on the spotted fever problem. With an appropriation of several thousand dollars he was in a position to prosecute the work in an effective manner. But he wished no interference by the entomologists and the Biological Survey. In fact he took the attitude that all the necessary information on the problem had been obtained by Dr. Ricketts. To a certain extent this was the case. Ricketts had suggested that the dipping of livestock would be an effective check on tick abundance, but he was in error concerning the life history of the tick, believing that it was a one-year cycle, and had but little information on the relative importance of the different host animals. For Tuttle then to claim that the work at the Florence "camp" in 1910 was of no significance, that the problem was one solely for the health authorities and that all other agencies should be prevented from taking part in the investigation, showed a very limited appreciation of this complicated problem.

Unknown to the Bureau of Entomology and the Montana Experiment Station, Dr. Tuttle, as secretary of the State Board of Health, financed a dipping vat at Victor to be used by the Public Health and Marine Hospital Service. The situation thereby developed, of the State paying

for the construction of a vat in one part of the valley and asking residents of another part to construct their own vat caused no small amount of dissention. It placed the other agencies in a very awkward position to say the least and created a resentment that lasted for several years amongst a local population that was not too thoroughly convinced on the "tick theory" anyway.

The Public Health and Marine Hospital Service pressed the tick-control work during 1911 and devoted only secondary attention to the other aspects involved. The idea seemed to be prevalent that the extermination of the adult ticks on livestock would solve the problem. As one surveys the situation now some twenty years later, it is plain that this is only one phase of a complete control program and that dipping as then conceived could bring about the destruction of but a small percentage of ticks. We can dismiss this rather hectic period of our history with the statement that none of the workers grasped the interlocking complications which gradually have woven themselves into the tick control work.

In September, 1911, the Bureau of Entomology and the Biological Survey withdrew from the work. King was sent to South Carolina on the pellagra investigations but the work which he started on the longevity of the wood tick was continued by Prof. R. A. Cooley through the succeeding summer and resulted in the discovery of some very remarkable habits and adaptations.

The Public Health and Marine Hospital Service continued their control work in 1912, being represented by Drs. T. B. McClintic and Wm. C. Rucker. The first fatality among the scientific workers on Rocky Mountain spotted fever due directly to close association with the disease, occurred this summer when Dr. McClintic became ill and died after a rather short duration of fever. The case was important not only from the standpoint of losing a valuable worker but, as there was no definite evidence that he had been bitten by a tick, the old antagonism toward the tick transmission idea again made itself known.

The work of Dr. McClintic was continued by Dr. Rucker in 1912 and the unpublished data reviewed and published by Dr. L. D. Fricks in 1914.

The year 1913 is an important one in the history of Rocky Mountain spotted fever. In January, Senator Fred Whiteside of Flathead County, introduced a bill in the Montana Legislature creating the State Board of Entomology supported by an appropriation of \$6,000. As finally passed, the board consisted of the Secretary of the Montana State Board of Health as chairman, the State Veterinarian as a member, and the State Entomologist as secretary. Dr. Tuttle of the Board of Health had resigned in 1912 so that Dr. W. F. Cogswell became the chairman of the Board of Entomology. Under his leadership the Board of Entomology has carried out research and control activities in connection with Rocky Mountain spotted fever which are not unimportant, but its most valuable function has been in its capacity as coordinator and constant activator in the work of bringing the disease under control.

The Board of Entomology in its second meeting, March 24, 1913, began its coordinating duties. After some discussion of the whole proposition, telegrams were dispatched to Washington, D. C., asking the Bureau of Entomology and the U. S. Public Health Service for a conference in Montana in order that definite plans for the work might be made.

On April 11, 1913, Dr. W. D. Hunter, of the Bureau of Entomology, and Dr. L. D. Fricks, of the Public Health Service, met with the Board. Dr. Hunter stated that his organization was prepared to spend \$15,000 during the season and had brought with him Mr. H. P. Wood who was to conduct investigations on the life history of the tick and also on the efficiency of various dipping solutions. These latter activities were supported by funds over and in addition to the \$15,000 just referred to, this latter amount being for work of the Bureau under the local supervision of Prof. R. A. Cooley. Resolutions were adopted to the effect that the Bureau of Entomology be invited to take charge of the Stevensville dipping vat and all work to the north, and the Public Health Service to have charge of the Victor dipping vat and all work from Victor south. This was an agreeable division and was adhered to for the next several years.

In 1913 the Board of Entomology divided the Valley into three tick-control districts, namely the Florence, Stevensville and Victor districts. These were later increased as need developed. It passed regulations governing the dipping and quarantine of cattle and in addition made a census of all livestock on the west side of the Valley. Preparations were also made for prosecuting the control work in 1914 on a more intensive basis than had been possible before. Arthur E. Seamans was employed by the Board of Entomology in 1913. He first worked in Owl Canyon, near Bozeman, but beginning July 1 was located at Florence and assisted in taking the stock census as well as in making further life history observations. H. P. Wood, of the Bureau of Entomology, was also at Florence during this season. His work was chiefly concerned with the life history of the tick but he also performed experiments on dipping and the use of sheep to collect ticks. This latter enterprise was begun in order to check the observations of Dr. L. D. Fricks who had reported to the State Board of Entomology that ticks would be killed by the lanolin of the sheep's wool.

Dr. W. V. King returned in 1914 to have charge of the work for the Bureau of Entomology with headquarters at Florence. Three general classes of work were followed—educational, control, and biological and experimental studies. In most sections the general attitude of the people toward the work showed a great change. No longer was it necessary to argue the question as to whether ticks were the transmitting agent or even to urge the desirability of tick extermination. There were other localities, however, where the educational side of the program was by far the most important in order to break down the inertia if not also real antagonism in regard to the work.

Dr. L. D. Fricks continued in charge of the Public Health Service program. The dipping of livestock was further investigated and at the

conclusion of the season's work, Fricks decided that while the practice of dipping would undoubtedly reduce the number of adult ticks, it would never serve as a very effective means of controlling spotted fever. He pressed instead the desirability of grazing sheep on heavily infested areas, the scheme being that the sheep would pick up great numbers of ticks which would be killed in the sheeps' wool. This promising idea was given no support by W. V. King, who, following up the work of Wood (1913) showed that enough adult ticks could develop on sheep to easily maintain a normal supply.

Up to 1914 Rocky Mountain spotted fever was confined particularly to the west side of the Bitter Root Valley. A few cases of a somewhat milder form of the disease had occurred in Carbon County. But in the spring of 1914 two cases developed in eastern Montana, one in Musselshell County and one in Richland County. In 1915 thirty-one cases of spotted fever were reported in several counties of Eastern Montana. Only two of them were fatal but this apparent spread of the infection brought a new and unexpected turn to the investigations upon the disease. As the work done previously in the Bitter Root Valley threw but little light on conditions in Eastern Montana, a new field station of the Montana State Board of Entomology was established at Powderville in 1916, a territory known to be infected. Dr. R. R. Parker was in charge of the work and was assisted by R. W. Wells. Studies on the bionomics of the ticks and the economic conditions which would need to be considered in a control program were made.

During 1915 to 1917 Dr. W. V. King remained in charge of the control work in the northern district of the Bitter Root Valley for the Bureau of Entomology. The general plan of the work consisted, first to prevent the engorgement of adult ticks on domestic animals as the principal measure, as in former years, and second, to supplement that by the destruction of small mammals which serve as hosts for the immature stages of the tick.

Similar work was superintended in the southern districts of the Valley by Dr. L. L. Fricks, representing the Public Health Service. In addition investigations on the nature of the virus of spotted fever were carried out.

It was in 1916 that the Board of Entomology invited Dr. S. B. Wolbach, of the Harvard Medical School, to study the casual organism of the disease. This work on the disease has continued ever since but was climaxed in 1919 at which time he published a complete report on *Dermacentroaenus rickettsi* Wolbach.

The Eastern Montana investigations of Dr. R. R. Parker and R. W. Wells on the habits and host relationships of the tick were moved to Musselshell County for the season of 1917. Previous work at Powderville represented a rather limited local condition but at Musselshell the comprehensiveness of the work was increased by the possibility of covering a much wider area.

The Modern Period

At the conclusion of the 1917 season both the U. S. Public Health Service and the U. S. Bureau of Entomology withdrew from the investigations and control operations in the Bitter Root Valley. With no federal agencies planning to carry on in 1918, the State Board of Entomology decided to place Dr. R. R. Parker in charge of the Bitter Root project. Parker had been prepared for this work by two years of intensive investigation on ticks in eastern Montana and was well qualified to carry out the program which had been adopted by the Board. He arrived at Victor in March, 1918, and has been intimately associated with the spotted fever problem ever since.

In 1918 for the first time, the control operations in the entire valley were unified under one organization. The campaign on the eradication of ticks was reorganized and during the succeeding years improved to such a degree that at least on the main floor of the entire valley the chance of persons picking up infective ticks was reduced to almost a negligible quantity. Practically all cases of spotted fever in these later years have originated outside of control districts, for the most part contracted from ticks picked up in some of the surrounding canyons.

Dr. Parker has called attention to the fact that the suppression of the disease in the valley cannot be entirely effective as long as the breeding of tremendous numbers of ticks in the Mountain goat ranges, very close to well populated sections, remains uncontrolled. The dipping and present handling of livestock and rodent destruction as a check on tick abundance have reached a static condition. An equilibrium between the control work in the valley and reinfestation from the mountain canyons, due to the migrations of such small mammals as the Columbian ground squirrel, has become established. More than this cannot be expected without some major change in the entire concept of the control program.

The smallest number of cases of Rocky Mountain spotted fever occurred in 1918 since any accurate records have been kept. In the years immediately following, however, there occurred an alarming increase of the disease. The Board of Entomology saw the necessity of more fundamental research on the disease. In spite of the general effectiveness of the control work so far as the elimination of ticks in the valley was concerned, it was evident this would not be enough to cut down the death toll. An increased appropriation so that the investigations might be expanded was requested from the 1921 legislature but was not obtained.

Fortunately, upon the appeal of the Montana State Board of Health and the State Board of Entomology, the U. S. Public Health Service consented to resume its investigation of the disease in Montana. Dr. R. R. Spencer was placed in charge for the Public Health Service. Dr. Parker who had held the title of assistant entomologist with the Board of Entomology was transferred to the Public Health Service as Special Expert. W. E. Pollinger was employed by the Board to look after the control

work and was followed later (1924) by Frank O'Donnell, who has had charge of this phase of the work ever since. This arrangement left Dr. Parker free to devote himself to the full time investigation of the disease although still available for frequent consultations relative to the campaign against rodents and other phases of the control work.

The beginning of the cooperation between Spencer and Parker constitutes an important land mark, for at that time the most comprehensive investigation of Rocky Mountain spotted fever yet undertaken was initiated. We cannot detail the many important contributions that have been made by Spencer and Parker and their associates in the U. S. Public Health Service. Most outstanding, however, has been the development of a prophylactic vaccine, a phenolized virus prepared from the tissues of infected ticks (*D. andersoni* Stiles). The first attempts toward preparation of the vaccine were made in 1922. By 1924 a product was developed that was effective in preventing the disease in guinea pigs, rabbits and monkeys. Its harmlessness to man was demonstrated in 1925, after Dr. Spencer had subjected himself to the first treatment, and since that time the production and distribution of the vaccine has become a major activity at the Hamilton Laboratory of the Public Health Service. The vaccine has proved to be highly effective in preventing the disease. It has taken away the fear of the disease in the Bitter Root Valley by reducing the more virulent type of spotted fever to a milder form and stopping the mild infection altogether. No one can know how many cases of fever and deaths have been prevented in the Rocky Mountain states by the free distribution of this vaccine. In extremely bad tick years such as 1932, without the vaccination the number of deaths in Montana might have been appalling.

Dr. Hideyo Noguchi, of the Rockefeller Institute, conducted experiments in the laboratories of that organization in New York City as well as at the Northern Pacific Hospital in Missoula, relative to the production of a prophylactic serum for spotted fever. While in Montana in 1923 Dr. Noguchi tried this serum on a number of Japanese employees of the Northern Pacific Railroad. Even after several years' work, however, the action of his immunizing agent was indefinite and never came into use to protect humans except in the experiment just referred to.

The limitations on the control work caused by the development of great numbers of ticks back in the mountain canyons, which cannot be reached by the methods in use—nor possibly by any system of tick destruction,—has been referred to. One chance existed by which ticks in these very inaccessible places could be reached. If some parasitic insect which lives in the bodies of ticks could be introduced and would become established, success might be attained. The high reproductive power of some such parasitic insect might enable it to overcome the ticks or at least keep their numbers down. In 1926 a parasite, *Ixodiphagus caucurtei* du Buysson, was introduced on Naushon Island, Massachusetts, in an attempt to control the American dog tick. It was learned through Dr. Emile Brumpt that this parasite would also attack *Dermacentor andersoni* Stiles, the principal vector of spotted fever. Arrangements were

made through Dr. S. B. Wolbach, of the Harvard Medical School, to obtain a supply of the parasite for cultivation and distribution in Montana. The State Board of Entomology undertook this parasite problem and carried it on until 1931. The attempt was very much worth while but the results have not been encouraging.

In 1928 the State of Montana completed a new laboratory at Hamilton to house the parasite and control work of the State Board of Entomology and also the much more extensive activities of the U. S. Public Health Service. Dr. R. R. Spencer returned to Washington that fall and Dr. R. R. Parker has since directed the operation of the Service Laboratory.

By 1930, it was apparent that investigations on Rocky Mountain spotted fever could not be confined to Montana. The disease had become a major problem in several of the western states. This fact was greatly emphasized by the increase in the production of the vaccine which became necessary. The vaccine project especially seemed to unify and centralize all interests in spotted fever at the Hamilton Laboratory. Larger quarters were needed for the expansion of the work. The Board of Entomology accordingly voted to sell the laboratory to the federal government and this was approved by the 1931 session of the state legislature. Following this the United States Congress passed the Walsh bill appropriating \$75,000 for the purchase of the Laboratory and \$75,000 for its enlargement. After the necessary appraisal of the building and equipment the sum of \$68,757 was paid by the federal government to the State of Montana on February 3, 1932, in full payment for the property. The investigations relative to tick parasites were transferred to the Public Health Service, thus leaving only the control work under the jurisdiction of the State Board of Entomology.

This account would not be complete without a parting tribute to the State Board of Entomology. The writer of this history can do this with some authority on account of his familiarity with the activities of the Board, and with some grace on account of having had nothing whatever to do with the organization until 1931. From 1913 to 1931 the Board's membership was not changed. Dr. W. F. Cogswell as chairman, Dr. W. J. Butler as member, and Prof. R. A. Cooley as secretary, worked together with a sincerity of purpose very seldom found in public office. Over a period of nineteen years they have fostered in one way or another, all the activities having to do with the suppression of spotted fever. Through their efforts the development of knowledge concerning the disease has not lagged. When there was danger of an interruption in the work due to the many discouragements and difficulties in the way of progress, the Board stood ready by their own efforts or by seeking the aid of federal agencies, to press on the work.

The problem which gave direct origin to the Montana State Board of Entomology has not been solved, but its status has changed from what seemed at one time a local problem to one of national and international importance. The U. S. Public Health Service is prosecuting the work on the disease with such vigor and success that there no longer is doubt as to the ultimate outcome.

**Men Who Have Died of Rocky Mountain Spotted Fever While Employed
In the Investigation of that Disease in Montana.**

THOMAS B. McCLINTIC, U. S. Public Health Service, 1912.

ARTHUR HOWARD M'CRAY, State Bacteriologist, June 14, 1919.

WILLIAM EDWIN GITTINGER, U. S. Public Health Service, June 30, 1922.

GEORGE HENRY COWAN, U. S. Public Health Service, October 29, 1924.

ARTHUR LeROY KERLEE, U. S. Public Health Service, February 14, 1928.

**ORGANIZATIONS WHICH HAVE CONTRIBUTED TO THE INVESTIGATION OF ROCKY MOUNTAIN SPOTTED FEVER
IN MONTANA, 1902-1933.**

The American Medical Association, Chicago, Illinois.

The Biological Survey, U. S. D. A., Washington, D. C.

The Bureau of Entomology, U. S. D. A., Washington, D. C.

Chambers of Commerce of Missoula and Hamilton, Montana.

The Chicago, Milwaukee & St. Paul Railway, Chicago, Illinois.

The Great Northern Railway, St. Paul, Minnesota.

Harvard University, Cambridge, Massachusetts.

The Memorial Institute of Infectious Diseases, Chicago, Illinois.

The Minnesota State Board of Health, Minneapolis, Minnesota.

Missoula County, Montana.

Montana Agricultural Experiment Station, Bozeman, Montana.

Montana State Board of Entomology, Bozeman, Montana.

Montana State Board of Health, Helena, Montana.

Montana State College, Bozeman, Montana.

Montana State Entomologist, Bozeman, Montana.

The Northern Pacific Railway, St. Paul, Minnesota.

Private Individuals in the Bitter Root Valley, Montana.

Ravalli County, Montana.

The Rockefeller Foundation, New York City.

The University of Chicago, Chicago, Illinois.

The University of Minnesota, Minneapolis, Minnesota.

University of Paris, Paris, France.

The U. S. Public Health Service, Washington, D. C.

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